RAE Systems Technical Note TN-114

Sensor Specifications and Cross-Sensitivities

Technical Note TN-114 presents specifications, cross-sensitivities, and calibration information on select RAE Systems sensors. All specifications presented in this Technical Note reflect the performance of standalone sensors. For instrument specifications, please refer product datasheets and manuals.

Actual sensor characteristics may differ when the sensor is installed in different instruments. As sensor performance may change over time, specifications provided are for brand new sensors.

All specifications have been verified under the following environmental conditions:

- Temperature:	68°F (20°C)
- Relative humidity (non-condensing):	50%
- Ambient pressure:	1 atm (1,013 mbar)

Please refer to the Glossary for specification definitions.

Specifications are subject to change without notice.

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Glossary

Range: The normal operating concentration of a sensor where the best linearity is found. Exceeding the normal operating range may result in erroneous readings and long recovery times, but should not permanently damage the sensor as long as the Max Overload is not exceeded.

Max Overload: The maximum exposure concentration. Exceeding this value will likely give erroneous readings and cause permanent damage to the sensor. This can be viewed as the sensor IDLH. Ammonia sensors often fail because they have been exposed to over 200 to 300 ppm (see Application Note AP-201).

Resolution: The least significant digit on the display or the minimum amount of chemical that the sensor can "see" (also known as: "Increment of measurement".)

Response Time (t_{90}): The time for a sensor to reach 90% of its final stable reading. Typically an exposure of twice the t_{90} time is required to get a stable reading. Response times of sensors and instruments may be different. The response time of instrument is dependent on sensor response time and test conditions like calibration gas flow rate, temperature etc.

Bias / Equilibration: Some electrochemical sensors (NO, NH_3) require a bias voltage to detect the gas, while most do not. Unbiased sensors may be shipped with a shorting pin across the electrodes to avoid an accidental bias. The pin should be removed before installation. Biased sensors require an equilibration time (also known as warm-up time) at least 6 hours after installation for the baseline to become stable enough to calibrate the sensor. Unbiased sensors require at least 10 minutes to stabilize. Once installed, any sensor bias stays on, even when the meter is off. Therefore, even biased sensors are ready for immediate use when the instrument is turned on again, and the equilibration time is needed only when first installed or if the battery becomes completely drained. The SensorRAE can be used to maintain bias on NO and other bias sensors, so long equilibration times can be avoided when installing such sensors into a multi-gas instrument.

Temperature Range: The normal operating temperature of the sensor. Sensors embody physico-chemical processes, which slow down when cooled and speed up when heated. Storing and using detectors outside in the winter may result in low readings if not recalibrated at the temperature of use. Storing detectors in hot cars in the summer may result in high readings and even dry out the sensors. Allowing a meter to return to normal operating temperature typically restores readings.

Pressure Range: The normal operating pressure of the sensor, typically atmospheric (14.7 psi) $\pm$10%. Some sensors have a transient response to sudden pressure changes, which may cause them to go into alarm for a short time.

Operating Humidity: Normal operating humidity. Typically 15 to 90% relative humidity, "non-condensing." Condensing humidity blocks the diffusion pathway, lowering the reading, and consistently high humidity can dilute the electrolyte and cause the cell to burst. Running or storing for extended periods in <10% RH gas can dry out the electrolyte and make the sensor inoperable.

Drift: The amount the sensor output may change over time, expressed in %.

Storage Life: The recommended maximum time a sensor should be stored in its original packaging before being installed in an instrument.

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Glossary (Continued)

Storage Temperature: The recommended temperature to store sensors prior to use.

Operating Life: The expected useable life of the sensor after it is installed, as long as the "Storage Life" was not exceeded before installation.

Warranty: The time from shipment up to which RAE Systems will replace a sensor free of charge, or at reduced charge, in case of failure. The warranty period is generally equal to or less than the Operating Life. Thus, a sensor with a storage life of 6 months, operating life of 2 years and warranty of 2 years, stored for 6 months before installation, is expected to be useable for up to 2½ years from the date of manufacture, even though the warranty expires 1½ years after it is installed. The warranty expiration date is programmed into the sensor and displayed during start-up of most RAE Systems single- and multi-gas meters. Sensors can be used beyond the expiration date provided that the sensor is properly zeroed and calibrated and the resolution is acceptable for the purpose of the measurements. The resolution can be tested by simply observing the zero fluctuations, or more accurately by measuring the response in the instrument's Diagnostic Mode according to Technical Note TN-123. The expiration date is provided on the instrument only as a reminder to the user that the warranty period for that sensor is complete and that it may become necessary to replace the sensor in the near future. The sensor, however, can operate properly beyond the expiration date as long as it responds to the gas of interest and is tested as noted above.

Calibration Gas: Recommended calibration gas concentration. A lower concentration might not give a stable calibration, while higher concentrations might use up the sensor prematurely. However, if the sensor is operated outside the typical range, it is recommended to use a calibration gas as close as possible to the actual concentrations and gas type being measured. For example, an NO sensor used to measure in the 200 to 500 ppm range is preferably calibrated with 500 ppm NO, instead of 25 ppm. A CO sensor used to measure 100-1,000 ppm hydrogen should be calibrated with 1,000 ppm hydrogen gas.

Calibration Flow Rate: Recommended calibration gas flow rate.

Cross-Sensitivity: Every sensor has some cross-sensitivity, where the sensor responds to other gases that are not filtered out and can react on the electrode. It is very important to be aware of potentially cross-sensitive compounds when interpreting data.

Sensors for Combustible Gases and Vapors

Combustible Gases and Vapors (LEL - 1)

Sensor Type: Protected catalytic bead
Gases Detected: Most combustible gases and vapors
Range: 0-100% LEL
Resolution: 1% LEL
Response Time (t_{90}): 30 sec.
Bias / Equilibration: No bias / 10 min. after installation
Drift: <10% LEL/month
Storage Life: 2 years in sealed container
Operating Life: 2 years in air
Warranty: 2 years from date of shipment
Calibration Gas: 50% LEL of Methane, or 2.5% by volume, balance air
Part Number(s): 014-0101-000, 008-1171-001
Supported Instruments: AreaRAE, MultiRAE IR, MultiRAE Plus, QRAE, RAEGuard, RAEGuard S

Catalytic Bead LEL - 1 Sensor Response Data

Compound	LEL Relative Sensitivity[1]	LEL CF
Acetone	45	2.2
Ammonia	125	0.8
Benzene	36	2.8
Carbon monoxide	83	1.2
Cyclohexane	40	2.5
Ethanol	59	1.7
Ethyl acetate	45	2.2
Hydrogen	43	2.3
Isobutylene	67	1.5
Isopropanol	38	2.6
Leaded gasoline	36	2.8
Methane	100	1
Methanol	34	2.9
Methyl ethyl ketone	38	2.6
n-Butane	63	1.6
n-Heptane	29	3.5
n-Hexane	30	3.3
n-Octane	26	3.8
n-Pentane	45	2.2
Phosphine	385	0.26
Propane	63	1.6
Propene	67	1.5
Toluene	29	3.5
Turpentine	34	2.9

[1] - Response of the RAE Systems LEL sensor to a range of gases at the same LEL, expressed as percent of Methane response (=100). These figures are for guidance only and are rounded to the nearest 5%. For the most accurate measurements, the instrument should be calibrated with the gas under investigation. See Technical Note TN-156 for more details and more compounds.

Combustible Gases and Vapors (LEL - 2)

Sensor Type: Protected catalytic bead
Gases Detected: Most combustible gases and vapors
Range: 0-100% LEL
Resolution: 1% LEL
Response Time (t_{90}): 15 sec.
Bias / Equilibration: No bias / 10 min. after installation
Drift: <10% LEL/month
Storage Life: 2 years in sealed container
Operating Life: 2 years in air
Warranty: 2 years from date of shipment
Calibration Gas: 50% LEL of Methane, or 2.5% by volume, balance air
Part Number(s): 014-0114-000, C03-0911-000
Supported Instruments: MultiRAE Family, ToxiRAE Pro LEL

Catalytic Bead LEL - 2 Sensor Response Data

Compound	LEL Relative Sensitivity[1]	LEL CF
Acetone	45	2.2
Ammonia	125	0.8
Benzene	40	2.5
Carbon monoxide	83	1.2
Cyclohexane	40	2.5
Ethanol	59	1.7
Ethyl acetate	45	2.2
Hydrogen	83	1.2
Isobutylene	67	1.5
Isopropanol	38	2.6
Leaded gasoline	42	2.4
Methane	100	1
Methanol	67	1.5
Methyl ethyl ketone	38	2.6
n-Butane	63	1.6
n-Heptane	37	2.7
n-Hexane	40	2.5
n-Octane	34	2.9
n-Pentane	50	2
Phosphine	385	0.26
Propane	63	1.6
Propene	59	1.7
Toluene	33	3
Turpentine	34	2.9

[1] - Response of the RAE Systems LEL sensor to a range of gases at the same LEL, expressed as percent of Methane response (=100). These figures are for guidance only and are rounded to the nearest 5%. For the most accurate measurements, the instrument should be calibrated with the gas under investigation. See Technical Note TN-156 for more details and more compounds.

Combustible Gases and Vapors (NDIR, % LEL Methane)

Sensor Type:	NDIR CH_4 % LEL (Non-dispersive infrared)
Gases Detected:	Methane (CH_4)
Range:	0-100% LEL (0-5.0% Vol. CH_4)
Resolution:	1% LEL
Response Time (t_{90}):	30 sec.
Equilibration:	1 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±20%
Operating Humidity:	0-95% non-condensing
Drift:	<5% signal/month
Storage Life:	2 years in sealed container
Storage Temperature:	-40°F to 122°F (-40°C to 50°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	50% LEL CH_4, balance air or N_2
Part Number(s):	C03-0962-000
Supported Instruments:	MultiRAE Lite Pumped, MultiRAE, MultiRAE Pro

Combustible Gases and Vapors (NDIR, % Vol. Methane)

Sensor Type:	NDIR CH_4 % Vol. (Non-dispersive infrared)
Gases Detected:	Methane (CH_4)
Range:	0-100% Vol. Methane (CH_4)
Resolution:	0.1% Vol.
Response Time (t90):	30 sec.
Equilibration:	1 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±20%
Operating Humidity:	0-95% non-condensing
Drift:	<5% signal/month
Storage Life:	2 years in sealed container
Storage Temperature:	-40°F to 122°F (-40°C to 50°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	20% Vol. CH_4, balance air or N_2
Part Number(s):	C03-0963-000
Supported Instruments:	MultiRAE Lite Pumped, MultiRAE, MultiRAE Pro

Oxygen Sensors

Oxygen (O_2)

Sensor Type:	Electrochemical
Range:	0 to 30% Vol.
Resolution:	0.1% Vol.
Response Time (t_{90}):	15 sec.
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Calibration Gas:	Ambient air (20.9% oxygen) or 18% O_2
Zero Gas:	99.9% N_2
Part Number(s):	170-0003-002, 008-1161-000, C03-0942-000
Supported Instruments:	AreaRAE, MultiRAE Family, MultiRAE IR, MultiRAE Plus, QRAE, QRAE+, RAEGuard EC, ToxiRAE Pro, VRAE, ToxiRAEII

Note: Measurements can be made in pure ethylene; recovery to ambient air may require a few hours.

Oxygen (O_2) - SPE O_2

Sensor Type:	Electrochemical (Solid Polymer Electrolyte)
Range:	0 to 30% Vol.
Resolution:	0.1% Vol.
Response Time (t_{90}):	30 sec.
Bias / Equilibration:	-600 mV / 30 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ± 10%
Operating Humidity:	15-90% non-condensing
Drift:	< 2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Calibration Gas:	Ambient air (20.9% oxygen) or 18% O_2
Zero Gas:	99.9% N_2
Part Number(s):	022-0300-000
Supported Instruments:	QRAE II

Electrochemical Sensors for Toxic Gases

Ammonia (NH_3)

Sensor Type:	Electrochemical
Range:	0-100 ppm
Resolution:	1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 104°F (-20°C to 40°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal loss / month
Storage Life:	1 year in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	50 ppm NH_3, balance N_2
Part Number(s):	170-0025-000, 008-1125-000, C03-0950-000
Supported Instruments:	AreaRAE, MeshGuard, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE+, RAEGuard EC, ToxiRAE II, ToxiRAE Pro, VRAE

Cross-Sensitivity Data, NH_3 Sensor

Gas	Concen-tration	Response
Alcohols	1,000 ppm	0 ppm
CO	100 ppm	0 ppm
CO_2	5,000 ppm	0 ppm
H_2	10,000 ppm	0 ppm
H_2S	20 ppm	about 2 ppm[1]
Hydrocarbons	% range	0 ppm

[1] - Short exposure of less than few minutes.

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Carbon Monoxide (CO)

Sensor Type:	Electrochemical
Range:	0-500 ppm
Max Overload:	1,500 ppm
Resolution:	1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temp.:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Calibration Gas:	50 ppm CO, balance air
Part Number(s):	032-0100-000, 008-1112-000, C03-0906-000
Supported Instruments:	AreaRAE, MeshGuard, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE, QRAE+, RAEGuard, RAEGuard S, ToxiRAE II, ToxiRAE Pro, VRAE

Cross-Sensitivity Data, CO Sensor

Gas	Concen-tration	Response w/o Filter[1]	Response w/ Filter[2]
Acetylene	250 ppm	250 ppm	NT[3]
Butane	100 ppm	1 ppm	1 ppm
Cl_2	10 ppm	0-1 ppm	NT
Ethanol	200 ppm	0 ppm	0 ppm
Ethylene	100 ppm	16 ppm	NT
Ethylene oxide	125 ppm	>=40 ppm	NT
H_2	100 ppm	40 ppm	40 ppm
H_2S	10 ppm	0 ppm	0 ppm
HCl	10 ppm	0 ppm	0 ppm
Hexane	500 ppm	0 ppm	0 ppm
Isobutylene	100 ppm	9 ppm	4 ppm
Isobutylene	1,000 ppm	30 ppm	22 ppm
MEK	100 ppm	0 ppm	0 ppm
NH_3	100 ppm	0 ppm	0 ppm
Nitrogen	100%	0-4 ppm	NT
NO	35 ppm	0 ppm	0 ppm
NO_2	5 ppm	0 ppm	0 ppm
Propane	100 ppm	0 ppm	0 ppm
SO_2	5 ppm	0 ppm	0 ppm
TCE	100 ppm	25 ppm	15 ppm

[1] - New sensor specs. Used sensors show increasing response to VOCs. See Technical Note TN-121 for more information.

[2] - A disk-shaped activated carbon fiber filter (P/N 008-3006-005) placed on top of the CO sensor helps reduce the response to VOCs.

[3] - Not tested (NT).

Carbon Monoxide (CO) - Extended Range

Sensor Type:	Electrochemical
Range:	0-2000 ppm
Resolution:	10 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Part Number(s):	032-0100-202, 008-1126-000, C03-0903-000
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Cross-Sensitivity Data, CO Extended-Range Sensor

Gas	Concentration	Response w/o Filter[1]	Response w/ Filter[2]
Cl_2	10 ppm	0-1 ppm	NT[3]
Ethanol	200 ppm	0 ppm	0 ppm
Ethylene	100 ppm	<30 ppm	NT
H_2	100 ppm	<50 ppm	NT
H_2S	15 ppm	0 ppm	0 ppm
NO	35 ppm	-10-0 ppm[4]	NT
NO_2	5 ppm	0 ppm	0 ppm
SO_2	5 ppm	0 ppm	0 ppm

[1] - New sensor specs. Used sensors show increasing response to VOCs. See Tech. Note TN-121 for more information.

[2] - A disk-shaped activated carbon fiber filter (P/N 008-3006-005) placed on top of the CO sensor helps reduce the response to VOCs.

[3] - Not tested (NT).

[4] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

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Carbon Monoxide (CO) Compensated to Hydrogen (H_2)

Sensor Type:	Electrochemical
Range:	0-2,000 ppm
Max Overload:	4,000 ppm
Resolution:	1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	< 1% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	100 ppm CO, balance Air
Part Number(s):	170-0077-000, C03-0979-000
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Cross-Sensitivity Data, CO Sensor (H_2-compensated)

Gas	Concen-tration	Response
C_2H_4	400 ppm	<140 ppm
Cl_2	10 ppm	<0.05 ppm
H_2 (at 10°C)	900 ppm	18 ppm
H_2 (at 20°C)	900 ppm	36 ppm
H_2 (at 30°C)	900 ppm	54 ppm
NH_3	20 ppm	<0.02 ppm
NO	50 ppm	<1.5 ppm
NO_2	10 ppm	<0.05 ppm
SO_2	20 ppm	<0.1 ppm

CO+H_2S Combination Sensor

Sensor Type:	Electrochemical
Range:	CO: 500 ppm, H_2S: 200 ppm
Max Overload:	CO: 1,500 ppm , H_2S: 500 ppm
Resolution:	CO: 1ppm, H_2S: 0.5 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	< 1% signal/month
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	50 ppm CO, 10 ppm H_2S, balance air
Part Number(s):	170-0075-000, C03-0913-000
Supported Instruments:	MultiRAE Family

Cross-Sensitivity Data, CO+H_2S Combination Sensor

Gas	Concen-tration	H_2S Response	CO Response
Cl_2	1 ppm	0 ppm	0 ppm
CO	300 ppm	<6 ppm	300 ppm
H_2	100 ppm	0.03 ppm	20 ppm
H_2S	15 ppm	15 ppm	0-6 ppm
NO	35 ppm	1.0 ppm	0.1 ppm
NO_2	5 ppm	-1 ppm[1]	0.1 ppm
SO_2	5 ppm	1 ppm	0 ppm

[1] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

Chlorine (Cl_2)

Sensor Type:	Electrochemical
Range:	0 to 50 ppm
Resolution:	0.1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Temperature Effect:	No effect on sensitivity or zero
Pressure Range:	Atmospheric ±10%
Operating Humidity:	5 to 95% non-condensing
Drift:	< 10% signal / 6 months
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	10 ppm Cl_2, balance N_2
Part Number(s):	032-0121-000, 008-1116-001, C03-0978-000
Supported Instruments:	AreaRAE, MeshGuard, MultiRAE Family, MultiRAE-IR, MultiRAE+, QRAE +, ToxiRAE II, ToxiRAE Pro, VRAE

Cross-Sensitivity Data, Cl_2 Sensor

Gas	Concentration	Response
Br_2	1 ppm	1 ppm
ClO_2	1 ppm	3.5 ppm
CO	300 ppm	0 ppm
CO_2	10%	0 ppm
Ethanol	6.60%	0 ppm
H_2	1,000 ppm	0 ppm
H_2S	20 ppm	-6 ppm[1]
HCl	20 ppm	0 ppm
HCN	10 ppm	0 ppm
Hydrocarbons	% range	0 ppm
N_2	100%	0 ppm
NH_3	65 ppm	0 ppm
NO	35 ppm	0 ppm
NO_2	10 ppm	12 ppm
SO_2	5 ppm	0 ppm

[1] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

Chlorine Dioxide (ClO_2)

Sensor Type:	Electrochemical
Range:	0 to 1 ppm
Resolution:	0.01 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 104°F (-20°C to 40°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	5 to 95% non-condensing; no effect
Drift:	<5% signal/6 months
Temperature Effect:	<0.02 ppm increase from -4°F to 104°F (-20°C to 40°C)
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	0.8 ppm ClO_2 from gas generator or equivalent of 2 ppm Cl_2 Requires ClO_2 gas generator, Cl_2 surrogate gas, or quarterly factory calibration
Part Number(s):	170-0017-000, 008-1120-000, C03-0956-000
Supported Instruments:	ToxiRAE II, ToxiRAE Pro, MultiRAE Family, VRAE

Notes on ClO_2 Sensor Calibration and Operation:

ClO_2 sensors require a ClO_2 generator for calibration because this gas is too unstable to store in a cylinder. ClO_2 sensors may contain a built-in filter that removes Cl_2 and therefore using Cl_2 surrogate gas may not be possible when the filter is present. ClO_2 sensors without the filter may be calibrated using a Cl_2 surrogate gas. NO_2 is not a reliable surrogate whether filter is present or not. This sensor should not be exposed to H_2S, which plugs the on-board filter, unless the filter is absent.

Cross-Sensitivity Data, ClO_2 Sensor

[1] - Short exposure of < few minutes of <100 ppm, with filters.

[2] - With onboard filters removed.

[3] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air. ClO_2 sensors without the on-board filter have a negative cross-sensitivity to H_2S and other reducing gases, and may underestimate the ClO_2 concentration if H_2S is present.

Ethylene Oxide (ETO-A)

Sensor Type:	Electrochemical
Range:	0-100 ppm
Resolution:	1 ppm
Bias / Equilibration:	Bias on; 6 hours after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ± 10%
Operating Humidity:	15-90% non-condensing
Drift:	< 2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	20 ppm ETO, or equivalent of 50 ppm CO, balance air
Part Number(s):	032-0110-100, 008-1121-100, C03-0954-000
Supported Instruments:	MultiRAE Family, ToxiRAE Pro, VRAE

Correction Factors, ETO-A Sensor

Gas	Correction Factor
Ethylene oxide	1
Carbon monoxide	2.5
Ethanol	2
Methanol	0.5
i-Propanol	5
i-Butylene	2.5
Butadiene	0.9
Ethylene	0.8
Propene	1.7
Vinyl chloride	1.3
Vinyl acetate	2
Formic acid	3.3
Ethyl ether	2.5
Formaldehyde	1

Ethylene Oxide (ETO-B)

Sensor Type:	Electrochemical
Range:	0-10 ppm
Resolution:	0.1 ppm
Bias / Equilibration:	Bias on; 6 hours after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	6 ppm ETO, or equivalent of 15 ppm CO, balance air
Part Number(s):	032-0110-200, C03-0922-100
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Correction Factors, ETO-B Sensor

Gas	Correction Factor
Ethylene oxide	1
Carbon monoxide	2.5
Ethanol	0.8
Methanol	0.3
i-Propanol	1.3
Formaldehyde	0.5
i-Butylene	0.9
Butadiene	0.3
Ethylene	0.7
Propene	0.8
Vinyl chloride	1.3
Vinyl acetate	0.5
Formic acid	1.4
Acrylonitrile	2.5

Ethylene Oxide (ETO-C) - Extended Range

Sensor Type:	Electrochemical
Range:	0-500 ppm
Resolution:	10 ppm.
Bias / Equilibration:	Bias on; 6 hours after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	40 ppm ETO, or equivalent of 100 ppm CO, balance air
Part Number(s):	032-0110-300, C03-0923-100
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Correction Factors, ETO-C Sensor

Gas	Correction Factor
Ethylene oxide	1
Carbon monoxide	2.5
Ethanol	2.5
Methanol	0.5
i-Propanol	5
i-Butylene	2.5
Butadiene	0.9
Ethylene	0.8
Propene	1.7
Vinyl chloride	1.4
Vinyl acetate	2.5
Formic acid	5

Formaldehyde (HCHO)

Sensor Type:	Electrochemical
Range:	0-10 ppm
Resolution:	0.01 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Storage Life:	6 months in sealed container
Storage Temp:	37°F to 68°F (5°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	9 ppm HCHO, or equivalent of 50 ppm CO, balance air
Part Number(s):	170-0078-000, C03-0982-000
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

The Formaldehyde sensor has cross-sensitivity to other gases. Please refer to Technical Note 128 for list of compounds with positive and negative cross-sensitivities to HCHO sensor and the recommended method if use. Care should be taken to limit the use of HCHO sensor to the compounds discussed in TN128 with known cross-sensitivity behavior. Customers wishing to order instruments with any other sensor combination involving the HCHO sensor should contact RAE systems.

Cross-Interfering Compound	CO (Carbon Monoxide)	H_2 (Hydrogen)	HCN (Hydrogen Cyanide)	H_2S (Hydrogen Sulfide)	C_4H_8 (Isobutylene)	NO (Nitric Oxide)	PH_3 (Phosphine)	SO_2 (Sulfur Dioxide)
Cross-Interfering Compound Concentration	50 ppm	200 ppm	10 ppm	10 ppm	100 ppm	25 ppm	5 ppm	5 ppm
HCHO Sensor Cross-Sensitivity Level	Moderate positive	Minimal	Moderate positive	**High positive**	**High positive**	Slight positive	**High positive**	Moderate positive
HCHO Sensor Cross-Sensitivity Approximate Value	20%	1-2%	25%	**150%+**	**100%+**	10%	**100%+**	30%

Cross-Interfering Compound	Cl_2 (Chlorine)	NO_2 (Nitrogen Dioxide)
Cross-Interfering Compound Concentration	1 ppm	5 ppm
HCHO Sensor Cross-Sensitivity Level	Moderate negative	Moderate negative
HCHO Sensor Cross-Sensitivity Approximate Value	-20%	-20%

Hydrogen (H_2)

Sensor Type:	Electrochemical
Range:	0-1,000 ppm
Max Overload:	2,000 ppm
Resolution:	2 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	200 ppm H_2, balance air
Part Number(s):	170-0076-000, C03-0981-000
Supported Instruments:	MultiRAE Lite (diffusion), ToxiRAE Pro

Cross-Sensitivity Data, H_2 Sensor

Gas	Concen-tration	Response
Cl_2	1 ppm	0 ppm
CO	300 ppm	<=60 ppm
Ethylene	100 ppm	80 ppm
H_2S	15 ppm	<3 ppm
HCl	5 ppm	0 ppm
HCN	10 ppm	3 ppm
NO	35 ppm	10 ppm
NO_2	5 ppm	0 ppm
SO_2	5 ppm	0 ppm

Hydrogen Cyanide (HCN)

Sensor Type:	Electrochemical
Range:	0-50 ppm
Max Overload:	100 ppm
Resolution:	1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to +50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temp.:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	10 ppm HCN, balance N_2
Part Number(s):	170-0012-000, 008-1117-000, C03-0949-000
Supported Instruments:	AreaRAE, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE+, ToxiRAE II, ToxiRAE Pro, VRAE

Cross-Sensitivity Data, HCN Sensor

Gas	Concen-tration	Response
CO	300 ppm	15 ppm
Ethylene	100 ppm	25 ppm
H_2	200 ppm	0 ppm
H_2S	15 ppm	90 ppm[1]
NO	35 ppm	-28 to ~0 ppm[2]
NO_2	5 ppm	-20 to -10ppm[2]
SO_2	20 ppm	40~75 ppm

1- Due to a very high cross-sensitivity to H S, this sensor is unsuitable for use in atmospheres that contain H2 S.

[2] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

Hydrogen Sulfide (H_2S)

Sensor Type:	Electrochemical
Range:	0-100 ppm
Max Overload:	500 ppm
Resolution:	0.1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	< 2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Calibration Gas:	10 ppm H_2S, balance N_2
Part Number(s):	032-0102-000, 008-1111-000, C03-0907-000
Supported Instruments:	AreaRAE, MeshGuard, MultiRAE-IR, MultiRAE+, MultiRAE Family, QRAE, QRAE+, RAEGuard, RAEGuard S, ToxiRAE II, ToxiRAE Pro, VRAE

Cross-Sensitivity Data, H_2S Sensor

Gas	Concentration	Response
CO	300 ppm	<=1.5 ppm
CS_2	100 ppm	0 ppm
Ethyl sulfide	100 ppm	10 ppm[2]
Ethylene	100 ppm	<= 0.2 ppm
H_2	3,000 ppm	0 ppm
HCl	10 ppm	0 ppm
HCN	10 ppm	0 ppm
Isobutylene	100 ppm	0 ppm
Methyl mercaptan	5 ppm	about 2 ppm
Methyl sulfide	100 ppm	9 ppm
NH_3	50 ppm	0 ppm
NO	35 ppm	<0.7 ppm
NO_2	5 ppm	about -1 ppm[1]
PH_3	5 ppm	about 4 ppm
SO_2	5 ppm	about 1 ppm
Toluene	10000 ppm	0 ppm[2]
Turpentine	3000 ppm	about 70 ppm[2]

Note: High levels of polar organic compounds including alcohols, ketones, and amines give a negative response.

[1] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

[2] - Estimated based on data from similar sensors.

Hydrogen Sulfide (H_2S) - Extended Range

Sensor Type:	Electrochemical
Range:	0-1,000 ppm
Resolution:	1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	< 2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Calibration Gas:	25 ppm H_2S, balance N_2
Part Number(s):	032-0102-100, 008-1111-200, C03-0904-000
Supported Instruments:	AreaRAE, MultiRAE Family, QRAE+, ToxiRAE Pro

Cross-Sensitivity Data, H_2S Extended-Range Sensor

Gas	Concen-tration	Response
CO	300 ppm	0 ppm
Ethylene	100 ppm	0 ppm
H_2	1,000 ppm	0 ppm
NO	35 ppm	<3 ppm
NO_2	5 ppm	0 ppm
SO_2	5 ppm	0 ppm

Methyl Mercaptan (CH_3SH)

Sensor Type:	Electrochemical
Range:	0-10 ppm
Max Overload:	20 ppm
Resolution:	0.1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ± 10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	37°F to 68°F (5°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	5 ppm CH_3SH, balance air
Part Number(s):	032-0120-000, C03-0980-000
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Cross-Sensitivity Data, CH_3SH Sensor

Gas	Concen-tration	Response
CO	100 ppm	<0.2 ppm
H_2	20,000 ppm	<1 ppm
H_2S	15 ppm	33 ppm
NO	35 ppm	<0.5 ppm
NO_2	5 ppm	<-3 ppm[1]
SO_2	5 ppm	<2.5 ppm

[1] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

Sulfur Dioxide (SO2)

Sensor Type:	Electrochemical
Range:	0-20 ppm
Max Overload:	150 ppm
Resolution:	0.1 ppm
Bias / Equilibration:	Not required
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±20%
Operating Humidity:	15-90% non-condensing
Drift:	< 10% signal/year
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in clean air
Warranty:	1 year from date of shipment
Calibration Gas:	5 ppm SO2, balance N_2
Part Number(s):	008-1113-000, 045-1113-000
Supported Instruments:	MultiRAE, AreaRAE, Mesh guard

Cross-Sensitivity Data, SO2 Sensor

Gas	Concen-tration (ppm)	Reading (ppm SO2)
CO	300	<1
NO	50	0-5
NO_2	6	<-10
NH_3	20	0
H_2S	25	<0.1
H2	400	<1
HCN	10	<5
C2H2	10	<30
C2H4	50	<45

Note: The table above is not exclusive and other gases not included in the table may still cause a sensor to react. The figures in this table are typical values and should not be used as a basis for cross calibration. Cross sensitivities may not be linear and should not be scaled. All data based on a 5 minute gassing. For some cross interferents break through will occur if gas is applied for a longer time period.

Nitric Oxide (NO)

Sensor Type:	Electrochemical
Range:	0-250 ppm
Max Overload:	1,000 ppm
Resolution:	0.5 ppm
Bias / Equilibration:	Bias on; 6 hours after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	< 2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	25 ppm NO, balance N_2
Part Number(s):	032-0111-000, 008-1114-000, C03-0974-000
Supported Instruments:	AreaRAE, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE+, ToxiRAE II, ToxiRAE Pro, VRAE

Cross-Sensitivity Data, NO Sensor

Gas	Concen-tration	Response
ClO_2	1 ppm	–0.2 ppm[1]
CO	300 ppm	0 ppm
H_2S	15 ppm	-1.5 ppm[1]
HCl	10 ppm	about 0.5 ppm
NH_3	50 ppm	0 ppm
NO_2	5 ppm	about 1.5 ppm
SO_2	5 ppm	0 ppm

[1] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

Nitrogen Dioxide (NO_2)

Sensor Type:	Electrochemical
Range:	0-20 ppm
Max Overload:	150 ppm
Resolution:	0.1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	5 ppm NO_2, balance air
Part Number(s):	032-0112-000, 008-1115-000, C03-0975-000
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Cross-Sensitivity Data, NO_2 Sensor

Gas	Concen-tration	Response
Cl_2	1 ppm	-1 ppm[1]
CO	300 ppm	0 ppm
H_2S	15 ppm	-1.2 ppm[1]
NO	35 ppm	0 ppm
SO_2	5 ppm	-5 ppm[1]

[1] - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

Phosphine (PH_3) - 1

Sensor Type: Electrochemical
Range: 0-5 ppm
Max Overload: 20 ppm
Resolution: 0.1 ppm
Bias / Equilibration: No bias / 10 min. after installation
Temperature Range: -4°F to 122°F (-20°C to 50°C)
Pressure Range: Atmospheric ±10%
Operating Humidity: 15-90% non-condensing
Drift: <10% signal/month
Storage Life: 6 months in sealed container
Storage Temperature: 32°F to 68°F (0°C to 20°C)
Operating Life: 1 year in air
Warranty: 1 year from date of shipment
Calibration Gas: 5 ppm PH_3, balance N_2
Part Number(s): 032-0108-000, 008-1119-000
Supported Instruments: AreaRAE, MultiRAE IR, MultiRAE+, QRAE+, ToxiRAE II, VRAE

Cross-Sensitivity Data, PH_3 - 1 Sensor

Gas	Concen-tration	Response
Arsine	150 ppb	0 ppb
Arsine	2,000 ppb	1,200 ppb[1]
Benzene	100 ppm	0 ppm
Chloroform	Headspace[2]	0 ppm
CF_2Cl_2	100 ppm	0 ppm
CO	1,000 ppm	0 ppm
CO_2	50,000 ppm	0 ppm
Diborane	300 ppb	105 ppb
Ethylene	100 ppm	0 ppm
Ethylene oxide	10 ppm	0 ppm
Germane	600 ppb	510 ppb
H_2	1,000 ppm	0 ppm

Gas	Concen-tration	Response
H_2S	15 ppm	12 ppm
HCl	10 ppm	0.2 ppm
HCN	10 ppm	0.6 ppm
Hexane, n-	1,500 ppm	0 ppm
Isobutylene	250 ppm	0 ppm
Methane	50,000 ppm	0 ppm
NH_3	100 ppm	0 ppm
NO	100 ppm	0 ppm
Silane	1,000 ppb	900 ppb
SO_2	5 ppm	1 ppm
Toluene	100 ppm	0 ppm
Trichloroethylene	Headspace[2]	<0.3 ppm

[1] - Response after 9 minutes of exposure. CF = 1.7 on average, tested in the range from 500 to 3,000 ppb AsH_3

[2] - Concentration in the headspace of the bottle with pure liquid chemical

Phosphine (PH_3) - 2

Sensor Type: Electrochemical
Range: 0-20 ppm
Resolution: 0.1 ppm
Bias / Equilibration: No bias / 10 min. after installation
Temperature Range: -4°F to 122°F (-20°C to 50°C)
Pressure Range: Atmospheric ± 10%
Operating Humidity: 15-90% non-condensing
Drift: <2% signal/month
Storage Life: 6 months in sealed container
Storage Temperature: 32°F to 68°F (0°C to 20°C)
Operating Life: 1 year in air
Warranty: 1 year from date of shipment
Calibration Gas: 5 ppm PH_3, balance air
Part Number(s): 032-0108-000, C03-0976-000
Supported Instruments: MultiRAE Family, ToxiRAE Pro

Cross-Sensitivity Data, PH_3 - 2 Sensor

Gas	Concentration	Response
CO	1,000 ppm	0 ppm
Ethylene	100 ppm	0 ppm
H_2	1,000 ppm	0 ppm
H_2S	15 ppm	12 ppm
NH_3	50 ppm	0 ppm
SO_2	5 ppm	0.9 ppm

Phosphine (PH_3) - Extended Range

Sensor Type:	Electrochemical
Range:	0-1,000 ppm
Resolution:	1 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ± 10%
Operating Humidity:	15-90% non-condensing
Drift:	<2% signal/month
Storage Life:	6 months in sealed container
Storage Temperature:	32°F to 68°F (0°C to 20°C)
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	100 ppm PH_3, balance air
Part Number(s):	032-0107-000, C03-0927-100
Supported Instruments:	MultiRAE Family, ToxiRAE Pro

Cross-Sensitivity Data, PH_3 Extended-Range Sensor

Gas	Concentration	Response
CO	1,000 ppm	0 ppm
Ethylene	100 ppm	0 ppm
H_2	1,000 ppm	0 ppm
H_2S	15 ppm	4 ppm
NH_3	50 ppm	0 ppm
SO_2	5 ppm	5 ppm

NDIR Sensors for Carbon Dioxide

Carbon Dioxide (CO_2) - 1

Sensor Type:	NDIR (Non-dispersive infrared)
Range:	0-50,000 ppm (0-5% Vol. CO_2)
Resolution:	100 ppm
Bias / Equilibration:	No bias / 10 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±20%
Operating Humidity:	5-95% non-condensing
Drift:	<5% signal/month
Storage Life:	2 years in sealed container
Storage Temperature:	-40°F to 122°F (-40°C to 50°C)
Operating Life:	2 years in air
Warranty:	2 years from date of shipment
Calibration Gas:	5,000 ppm CO_2, balance N_2
Zero Gas:	N_2
Part Number(s):	051-0011-000
Supported Instruments:	MultiRAE IR

Carbon Dioxide (CO_2) - 2

Sensor Type:	NDIR (Non-dispersive infrared)
Range:	0-50,000 ppm (0-5.0% Vol. CO_2)
Resolution:	250 ppm when below 25,000 ppm 500 ppm when above 25,000 ppm
Equilibration:	1 min. after installation
Temperature Range:	-4°F to 122°F (-20°C to 50°C)
Pressure Range:	Atmospheric ±20%
Operating Humidity:	0-95% non-condensing
Drift:	<5% signal/month
Storage Life:	2 years in sealed container
Storage Temperature:	-40°F to 122°F (-40°C to 50°C)
Operating Life:	2 years in air
Warranty:	1 year from date of shipment
Calibration Gas:	5,000 ppm CO_2, balance N_2
Zero Gas:	N_2
Part Number(s):	C03-0961-000
Supported Instruments:	MultiRAE Family

PID Sensors for Volatile Organic Compounds (VOCs)

PID, Parts-Per-Billion (10.6eV)

Sensor Type:	PID
Gases Detected:	VOCs (see Technical Note TN-106)
Range:	0-2,000 ppm (Isobutylene equivalent)
Resolution:	0.01 ppm (Isobutylene)
Response Time (t_{90}):	15 sec.
Bias / Equilibration:	No bias / 10 min. after installation
Zero Drift:	<10% signal/day
Span Drift:	<10% signal/day
Storage Life:	3 months in sealed container
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	10 ppm and 100 ppm Isobutylene for recommended 3-point cal.
Part Number(s):	C03-0912-001
Supported Instruments:	MultiRAE Pro

PID (10.6eV) - MultiRAE Extended Range

Sensor Type:	PID
Gases Detected:	VOCs (see Technical Note TN-106)
Range:	0-5,000 ppm (Isobutylene equivalent)
Resolution:	0.1 ppm (Isobutylene)
Response Time (t_{90}):	15 sec.
Bias / Equilibration:	No bias / 10 min. after installation
Zero Drift:	<10% signal/day
Span Drift:	<10% signal/day
Storage Life:	3 months in sealed container
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	100 ppm and 1000 ppm Isobutylene for recommended 3-point cal.
Part Number(s):	C03-0912-002
Supported Instruments:	MultiRAE, MultiRAE Pro

PID (10.6eV)

Sensor Type:	PID
Gases Detected:	VOCs (see Technical Note TN-106)
Range:	0-1,000 ppm (Isobutylene equivalent)
Resolution:	1 ppm (Isobutylene)
Response Time (t_{90}):	15 sec.
Bias / Equilibration:	No bias / 10 min. after installation
Zero Drift:	<10% signal/day
Span Drift:	<10% signal/day
Storage Life:	3 months in sealed container
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	100 ppm Isobutylene
Part Number(s):	C03-0912-003
Supported Instruments:	MultiRAE Lite Pumped, ToxiRAE Pro PID Safety Configuration

PID (10.6eV) - ToxiRAE Pro Extended Range

Sensor Type:	PID
Gases Detected:	VOCs (see Technical Note TN-106)
Range:	0-2,000 ppm (Isobutylene equivalent)
Resolution:	0.1 ppm (Isobutylene)
Response Time (t_{90}):	15 sec.
Bias / Equilibration:	No bias / 10 min. after installation
Zero Drift:	<10% signal/day
Span Drift:	<10% signal/day
Storage Life:	3 months in sealed container
Operating Life:	1 year in air
Warranty:	1 year from date of shipment
Calibration Gas:	100 ppm Isobutylene
Part Number(s):	C03-0912-000
Supported Instruments:	ToxiRAE Pro PID Industrial Hygiene Configuration

Sensor Cross-Sensitivities

Electrochemical sensors, like many other sensors, are known to have cross-sensitivity to gases other than its target gas. Depending on the nature of the reaction in the sensor, the gas can either decrease the signal (negative cross-sensitivity) or increase the signal (positive cross-sensitivity). The cross sensitivity data listed here are based on at most a few batches of electrochemical sensors. The actual values may vary between batches because the cross sensitivity is not typically controlled during the manufacturing process.

When calibrating a multi-gas instrument that has two sensors which gases have significant cross-sensitivity, be sure to allow adequate time between calibrations to allow the sensors to clear.

When calibrating sensors with cross-sensitivities, calibrate the most cross-sensitive first, followed by the least cross-sensitive. Wait for both sensors to recover to zero, then expose both to gas again with most cross sensitive first and least cross sensitive second. For example, 50 ppm of NH_3 produces 0 ppm response on a Cl_2 sensor and 1 ppm of Cl_2 produces about -0.5 ppm of response on a NH3 sensor. So calibrate the NH_3 sensor first with 50 ppm of NH_3. This should have no affect on the Cl_2 sensor. Then calibrate the Cl2 sensor on 10 ppm Cl2. This will send the NH_3 sensor negative for some period of time. After calibrating the Cl2 sensor, return the meter to clean air and wait until the most cross-sensitive sensor (NH_3) fully recovers and/or stabilizes (if it stabilizes to a number other than zero then re-zero the meter). After both sensors return to zero apply calibration gas in the same order (NH_3 first then Cl_2) and note the sensor response. If both sensors are within 10% of the value on the gas cylinder then the calibration of the cross-sensitive sensors was successful.

Use extreme caution with mixtures of gases!

The following **table and data** are based on % cross-sensitivity to a single gas.
Mixtures of the gases were not tested and results with mixed gases are unpredictable.
The tables below show cross-sensitivities of various sensors to different gases.

Item	Cross-Sensitivity Codes for Select Sensors Used in RAE Systems Monitors	
Positive cross-sensitivity	•	Slight positive cross-sensitivity (≦10% reading of the specified gas)
	••	Moderate positive cross-sensitivity (10-50% reading of the specified gas)
	•••	High positive cross-sensitivity (>50% reading of the specified gas)
Negative cross-sensitivity	†	Slight negative cross-sensitivity (-10% to 0 reading of the specified gas)
	††	Moderate negative cross-sensitivity (-10% to -50% reading of the specified gas)
	†††	High negative cross-sensitivity (<-50% reading of the specified gas)
No data	Blank	

From the safety standpoint, a negative cross-sensitivity may present a higher risk than a positive one, as it will diminish the response to the target gas and so prevent an alarm.

Cross-Sensitivity	Gas							
Sensor	CO	H_2S	SO_2	NO	NO_2	HCN	NH_3	PH_3
CO		•	•	•	•			
CO-Extended Range		•	•	††	•			
CO-H_2 Compensated			•	•	•		•	
H_2S	•		••	•	††			
H_2S-Extended Range	•		•	•	•			
SO_2	•	•		•	†††			
NO	•	†	•		••			
NO_2	•	†	†††	•				
HCN	•	•••	•••	††	†††			
NH_3	•	•						
PH_3	•	•••	••				•	
PH_3-LR	•	•••	••				•	
PH_3-Extended Range	•	••	•••				•	
ETO-A	••							
ETO-B	••							
ETO-C	••							
Cl_2	•	††	•	•	•••		•	
	•	††						
H_2	••	••	•	••	•	•		
CH_3SH	•	•••	••	•	††			
HCHO	••							

CAUTION! Negative cross-sensitivitiesmay cause sensors to produce lower readings than the true concentration of gas in the air.

Cross-Sensitivity	Gas						
Sensor	HCl	ETO	Cl_2	ClO_2	H_2	CH_3SH	HCHO
CO			••		••		
CO-Extended Range			••		•••		
CO-H_2 Compensated			•	•	•		
H_2S					•		
H_2S-Extended Range					•		
SO_2							
NO							
NO_2			†††				
HCN							
NH_3					•		
PH_3					•		
PH_3-LR					•		
PH_3-Extended Range					•		
ETO-A							
ETO-B							
ETO-C							
Cl_2				•••	•		
ClO_2			•••		•		
H_2	•		•				
CH_3SH					•		
HCHO							

CAUTION! Negative cross-sensitivitiesmay cause sensors to produce lower readings than the true concentration of gas in the air.

Cross-Sensitivity, %	Gas							
Sensor	CO	H_2S	SO_2	NO	NO_2	HCN	NH_3	PH_3
CO	100%	0%	0%	0%	0%			
CO-Extended Range	100%	0%	0%	-29%	0%			
CO-H_2 Compensated	100%		3%	6%	5%		1%	
H_2S	1%	100%	20%	2%	-20%			
H_2S-Extended Range	0%	100%	0%	9%	0%			
SO_2	1%	0%	100%	0%	-100%			
NO	0%	-10%	0%	100%	30%			
NO_2	0%	-8%	-100%	0%	100%			
HCN	5%	600%	375%	-80%	-400%	100%		
NH_3	0%	10%					100%	
PH_3 (032-0108-000)	0%	80%	20%				0%	100%
PH_3	0%	80%	20%				0%	100%
PH_3-Extended Range	0%	27%	100%				0%	100%
ETO-A	40%							
ETO-B	40%							
ETO-C	40%							
Cl_2	0%	-30%	0%	0%	120%		0%	
ClO_2	0%	-25%						
H_2	20%	20%	0%	29%	0%	30%		
CH_3SH	0%	220%	50%	1%	-60%			
HCHO	70%							

CAUTION! Negative cross-sensitivitiesmay cause sensors to produce lower readings than the true concentration of gas in the air.

Cross-Sensitivity, %	Gas						
Sensor	HCl	ETO	Cl_2	ClO_2	H_2	CH_3SH	HCHO
CO			10%		40%		
CO-Extended Range			10%		50%		
CO-H_2 Compensated			5%		1%		
H_2S					0%		
H_2S-Extended Range					0%		
SO_2							
NO							
NO_2			-100%				
HCN							
NH_3					0%		
PH_3 (032-0108-000)					0%		
PH_3					0%		
PH_3-Extended Range					0%		
ETO-A		100%					
ETO-B		100%					
ETO-C		100%					
Cl_2			100%	350%	0%		
ClO_2			60%	100%	0%		
H_2	0%		0%		100%		
CH_3SH					0%	100%	
HCHO							100%

CAUTION! Negative cross-sensitivitiesmay cause sensors to produce lower readings than the true concentration of gas in the air.

Extended Calibration and Soak Times

Most RAE systems instruments (MultiRAE family, ToxiRAE Pro, etc.) incorporating electrochemical or NDIR sensors should follow the instrument calibration time and soak time as outlined in the table below. Teflon tubing (1ft is recommended) should be used for calibration and verification testing for reactive gases.

Automatic vs. Manual Calibration:
When used in automatic calibration mode (with AutoRAE2), soak time is required to ensure proper gas concentration delivery during calibration. The soak time can be set through ProRAE studio II using the guideline in the table below.

When used in manual calibration mode, instrument calibration time is sufficient.

Sensor	Sensor Response Time (t_{90}, sec.)	Instrument Calibration Time (sec.)	AutoRAE2 Soak Time (sec.)
Cl_2	30	200	90
ClO_2	120	150	90
CO_2	60	120	45 (std. cal.)
HCN	200	230	170
NH_3	60	180	120
PH_3	60	120	60
SO_2	75	120	60

Guideline for Manual Calibration of Classic Instruments:
Some classic instruments (Area RAE, MultiRAE Plus, QRAE Plus, etc.) have a fixed calibration time (typically 60 sec.) programmed into the instrument. When doing manual calibration it is recommended to extend the amount of time the sensor is exposed to gas to match values summarized in the above table. As a reminder newer instruments like the MultiRAE and ToxiRAE Pro family automatically adjust the programmed calibration time in the instrument to those listed in the table so there is no need to apply gas in advance of starting the countdown sequence.

For example, when performing calibration of the MultiRAE Plus for Cl2, apply gas for 140 seconds prior to pressing the [Y/+] to start the programmed calibration time countdown of 60 seconds. In this case the sensor is exposed to Cl2 gas for a total of 200 seconds during the calibration process ensuring an accurate calibration.